

The Ought-Ecology of Ferals: An Emerging Dialogue in Invasion Biology and Animal Studies

Anna Wilson¹, David Wilson² & Libby Robin^{3,4}

¹ Birdlife Australia, 05/60 Leicester St, Carlton, Victoria, 3053 Australia. abottlefullofrain@gmail.com

² 121 Gingell St, Castlemaine, Victoria, 3450 Australia. djdwilson@gmail.com

³ Fenner School of Environment and Society, Australian National University, Canberra, 2600 Australia. libby.robin@anu.edu.au

⁴ Corresponding author

ABSTRACT

This paper considers how the natural sciences and humanities describe and discuss the biota described as 'feral', showing that it is employed differently by the various professionals and researchers. Recognizing that metaphors can colour outcomes for sustainability and for the animals themselves, we have explored the interdisciplinary context that has created this as a pejorative term. Through the lens of history, we explore how 'feral' has changed its meaning over time in practical management and research contexts. Specifically, we explore how labeling a species or population or group as *feral* shapes theoretical and practical aims for scientists, humanists and managers in the present and for the future.

Key words: alien species, civilization, conservation biology, domestication, ethics, feral animal management, invasion biology, native species, threatened species

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Introduction

'Feral: having become wild from a state of cultivation or domestication' (Darwin 1872: 559)

Domestication has historically been described as 'that revolution whereby man ceased to be purely parasitic and, with the adoption of agriculture and stock-raising, became a creator emancipated from the whims of his environment' (Childe 1928: 2). More recently in the present, it has become a 'science'. Melinda Zeder, for example defines it in terms of 'a coevolutionary mutualism between domesticator and domesticate ... [that] is distinguished from related but ultimately different processes of management and agriculture' (Zeder 2015: 3191). Zeder identifies the key research questions for domestication science as understanding the 'range of genotypic, phenotypic, plastic, and contextual impacts that can be used as markers of evolving domesticatory relationships' (Zeder 2015: 3191). Whether it is primarily approached from the perspective of the people (as in the approach of the archaeologist, Gordon Childe, above) or from the perspective of the biological organism (as Zeder has done), it undoubtedly has changed the relationship between humans and animals and plants, over a historical period spanning six millennia (Hemmer 1990). It is a crucial tool for managing the environment. Domestication is of continuing interest today as it is the

basis for most food in the globalized industrial world. It is still cited as a fundamental element of the narrative of western civilization, and is entrenched in global demographic patterns (Diamond 2002).

While domestication can be seen as the taming and controlling of nature to fulfil human need, it bears costs and responsibilities, both in a practical and philosophical sense. Domesticated plants and animals rely on humans for many aspects of their life cycle (food, breeding, planting), and often human technologies like artificial insemination, greenhouses and seedbanks have further developed their characteristics. Humans have come to manage and make part of human capital systems many elements of the most domesticated animals' lives, leading to discussions about human responsibility for animal wellbeing, as well as questions about the impact that industries based on animal domestication have on 'undomesticated nature'. The idea that some societies are more civilized (and others less) is crucially linked to the process of domestication (Robin 2017).

For example, geographer Gordon East argues that domestication is a key sign 'by which we distinguish 'civilization' from many cultures of a more primitive kind' (East 1965: 128). The level of domestication of animals dictates, to some extent, the 'ought' question:

How much control *should* humans exert over other creatures?

Nowhere is this responsibility more starkly portrayed than in the proposed geological epoch of the Anthropocene, where the impact of human behaviours is evident in biophysical systems at the local, regional and global levels (Steffen *et al.* 2015). The Anthropocene demands an ethos that includes each of those levels, and the interactions between them. As we grapple with the idea that we have left the Holocene era, we also acknowledge that humans, perhaps particularly western humans (Haraway 2015), have changed the course of evolution for the planet as a whole. If we have left the Holocene, the geological epoch in which most dominant civilizations today emerged, we are moving beyond a 'safe operating space' for humanity (Rockström *et al.* 2009). It is also a different place for all other biota. From an ecological point of view, "biosphere integrity", that is the losses of biodiversity, habitat and wild country have become the most serious of the Anthropocene changes in the longer term (Steffen *et al.* 2015).

The dialogue about the Anthropocene is rich. Initiated by Nobel Prize winner, Paul Crutzen at a meeting of global change scientists working on atmospheric change in the International Geosphere Biosphere Program (IGBP) (Steffen 2013), it has gained traction right across the interdisciplinary environment. Artistic and NGO activist communities also recognize the Anthropocene's global changes as a key challenge. We see headlines: *Welcome to the Anthropocene!*, for example in *The Economist*, 26 May 2011. A museum exhibition in Munich uses the same English title, with a subtitle *The Earth in Our Hands* (Robin *et al.* 2014: 212; See also Kolbert 2014). There is a feeling of responsibility in the air, of the need to adjust human behaviour that might re-route planetary futures. There is also critique. Is the Anthropocene hubristic? Does it reinforce ideas of human domination of the planet (Wuerthner *et al.* 2014)? Here we consider the question of natural resource management: is it possible to manage nature if humans and nature are so much more interdependent than hitherto thought?

Those opposed to controlling nature in 'wild' (undomesticated) places are critical of managing Earth for the benefit of one species. But there are many who want to *manage* wild nature too, adopting the language of *threatened species*, particularly since the mid-1980s. Ecologists Michael Soulé, Edward Wilson and Thomas Lovejoy promoted the term *biodiversity* as much more than a 'new name for nature' (Farnham 2007: 2). Conservation Biology itself became the 'science of crisis' (Soulé 1985), the IUCN published its first *Red List of Threatened Species* and new NGOs like Conservation International (established 1987) set targets on the basis of biodiversity (Robin 2011). The new discipline of Invasion Biology was also emerging in this period, although its lineage has been traced back to animal ecologist, Charles Elton's BBC radio talks in the 1950s (Richardson 2011). In his popular book *The Diversity of Life*,

Wilson described invasions of exotic animals as 'the second greatest threat' (after habitat destruction), thus linking biological expansion of alien invaders with threats to native species (Wilson 1992; Chew 2015). The parameters for biodiversity management were established before questions of global climate change arose, though now increasingly emphasise climate-changed habitats.

The Anthropocene describes a geological epoch, but it also captures a moment in which all sorts of different people are *at once* anxious and deeply troubled by just how much human behaviour has affected other species and ecological processes. This anxiety extends to the fact that these processes and creatures are apparently out of their control, and is aggravated by uncertainty about whether they should be trying to control at all (van Dooren 2011; Robbins and Moore 2013). Nowhere is the issue of control more salient than in the question of culling feral animals to save 'threatened biodiversity': here there are new forces, new metaphors and new questions that serve to focus on controlling the once-domesticated, now out of control animals 'damaging' native vegetation and threatening rare indigenous species.

In Gordon East's historic narrative of civilization, domestication is a signal of a linear story of progress, pinpointing a moment at which Western societies civilize and shift to more sedentary life styles. East comments that whereas Palaeolithic peoples 'were ignorant of the domestication of animals', Neolithic peoples 'by the exercise of great creative effort...during the period from 6000 to 3000 BC invented new ways of life', which gave them 'a new, if incomplete, power to adapt the natural environment' (East 1965: 129). This liminal moment marking the beginning of 'civilization' also defined the 'safe operating space' arguments of Rockström *et al.* (2009). If domestication is a sign of progress, this fuels anxiety about a fall from grace, particularly in settler societies like Australia and New Zealand with histories of anxiety about degeneration (Griffiths 1996). If de-domestication actually turns civilization 'as we know it' backward, it rouses added levels of anxiety. This is the context for the pejorative moniker *feral* in these societies (Robin 2017).

Feral is as much a historical term, as a technical one. Human anxieties about feral futures (Low 1999) have deep histories. History affects the way future possibilities unfold ecologically. For instance, for Schnitzler *et al.* (2011) feral landscapes are those that were once cultivated and then left to develop spontaneously, but these 'spontaneous' ecological processes derive at least in part from prior land uses. They are not simply natural processes (Schnitzler, Aumaitre *et al.* 2011). In this sense such landscapes can never be *wild*, as succession processes will take different courses and different lengths of time compared with natural processes and never return to pristine ecosystems (Schnitzler, Aumaitre *et al.* 2011). Whether succession can return a landscape to a previous 'climax' ecosystem or takes it to a new equilibrium is a contentious question as

we are now living in a time of ‘novel ecosystems’ (Hobbs 2009; Hobbs *et al.* 2006). Similarly, ‘feral animals’ are (usually) those that were once domesticated, or whose ancestors were once domesticated, but when released from their interdependence with human beings, they are uncontrollable, and have no prospect of being fully wild (e.g. Shelton 2004). Marris (2014) describes the case of the wolf-dog hybrid puppies that were destroyed in Oregon, USA, by biodiversity managers because they were neither wolf nor dog.

Using the term feral often reflects frustration about a lack of *control* over species or ecosystems. Feral is such an evocative adjective that it is even sometimes applied to out-of-control people. For example, the students who rioted in protest about pension changes in Lyon, France in October 2010 were referred to in the media as *férales* (LR pers. obs.). David Harvey takes the idea one step further and speaks of ‘feral capitalism’ (Harvey 2011). Feral is a term widely used in popular literature, where it may have different implications than in technical scientific literature, but there is a possibility of leakage between the popular and the technical. Feral has derogatory implications even where its use in the technical literature is nuanced and subtle (Richardson *et al.* 2000). In scientific literature, government documents and other grey literature, *feral* colours the reading of species.

This paper examines closely how ‘feral’ is applied and employed by professionals who interact with animals in a professional research capacity, recognizing that the choice of words and metaphors can make significant differences to sustainability outcomes (Larson 2005; Larson 2011). Drawing on published work by scholars in both natural sciences and humanities, we look at the similarities and differences in their use of the word ‘feral’, from both historical and conceptual perspectives. Investigating the concept of ferality and its applications in a variety of research spheres enables us to explore underlying moral and ethical issues in relations between society and animals. Which creatures are considered valuable? Which are dismissed? Which animals cause anxiety – and is it fear of the animal or self-loathing? And finally which animals do people care about, and how far might this care extend to plants and other biota? By unpacking the concept of ferality in a historical context, we can see how it has become applied in practical management and theoretical contexts. Ultimately, we consider how it might be useful or not for the emerging future management options in the globally changed world of the Anthropocene. The paper seeks to explore whether labeling a species or population or group *feral* advances the theoretical and practical aims suggested by scientists, humanists and managers.

Materials and methods

We approached our investigation into the use of feral from both a qualitative and quantitative perspective, mirroring

the different approaches typically employed by the two research spheres in which we were interested.

To track the changing use of feral over time in the natural sciences, we searched Web of Science in February and March 2015 for the term ‘feral’ as a topic search. We then restricted results to the categories ‘Zoology’, ‘Ecology’, ‘Environmental Sciences’ and ‘Biodiversity Conservation’ to reflect our ecological area of interest. This returned 2485 results (or 1164 results, if based on ‘titles only’) for the period from 1936 (the first recorded use) until 2014, the latest available full year records. Using a ‘topic search’, the Web of Science only searches title data before 1990 (but expanded to titles, abstracts and keywords after this date, which makes strict compatibility difficult to do over the longer historical period spanning the 1990 change). However, the analyses we did used the full 2485 results, on the basis that there were far more results after 1986 than in the first 50 years anyway, consistent with Farnham’s analysis of the use of the term ‘biodiversity’ (Farnham 2007: 2).

For each record, we then noted the species or category to which ‘feral’ referred, observing that more than one species may be referred to as feral within a record, hence total mentions do not exactly match the number of records overall, or for many years. Where ‘feral’ was associated with a general category (e.g. feral fish), we tried to ascribe the record to a species if that was obvious from the record’s text. To determine how proportional use of the word feral for particular species has changed over time, we performed the same restricted search in Web of Science for records of the top two feral species, with and without the ‘feral’ label.¹

One of the most important new interdisciplinary fields within the humanities that directly considers animals, is Animal Studies. When we refer to the humanities perspective throughout the paper, we are referring to this particular area of study. As many of these humanities journals are not in a single data base, and many writers in this field publish in book format, we searched six major common animal studies journals (*Conservation and Society*, *Anthrozoos*, *Between the Species*, *Society and Animals*, *Humanimalia* and *Journal for Critical Animal Studies*) separately for their use of the term ‘feral’, and then collated the data as we had for the science journals. Note that none of these humanities journals were included in Web of Science. We also noted the total articles from these journals in the period of interest to look at absolute use of the term ‘feral’. For ground-truthing, we also briefly surveyed multi-authored books associated with key international conferences between 2012 and 2015 (Johnston and Probyn-Rapsey 2013; Burns and Paterson 2014; Human Animal Research Network Editorial Collective 2015). Broadly speaking, the chosen journals were representative of the book-length discussions among scholars in this emerging field, so we did not undertake further analysis of books.

¹ Exact search terms were ‘cat’ or ‘cats’ and ‘feral cat’ or ‘feral cats’, and ‘pig’ or ‘pigs’ and ‘feral pig’ or ‘feral pigs’.

To better understand the nuances of the use of the word, we interrogated selected articles spanning the full period of interest for their detailed meaning, context and relevance. These were used to fill our discussion of the conceptual meanings embodied by the term 'feral'.

Results

We found 2485 natural science records containing the word feral between 1936 and 2014 (Figure 1), while in the humanities animals studies journals we found 94 records of the word feral between 1985 and 2014 (Figure 2). As a proportion of total papers published in each canon, the use of feral in the humanities was *an order of magnitude greater* than that in the natural sciences ($3.20 \pm 0.46\%$ and $0.32 \pm 0.02\%$ respectively: mean \pm standard error, averaged over the last 30 years).

For the natural sciences represented in the sample, 'feral' first appeared in 1936, however it did not accrue more than 10 mentions in a single year until 1979 (Figure 1). This is broadly in line with Timothy Farnham's analysis of the word 'biodiversity' which rose sharply after 1986, and has a correlated history (Farnham 2007; Robin 2011) Use

of the word peaked in 2010 with 152 records, although feral has been fairly steadily used since 2006 (Figure 1). For the humanities, 'feral' was first used in 1985, five years after the first journals in the field was established, with a maximum number of mentions in 2013 although in fairly constant use since the mid-2000s (Figure 2).

In the natural sciences, feral was attributed to 182 identifiable species as well as 54 more general categories (Table 1). The distribution of mentions was highly skewed. The top five species account for more than half of all mentions: Cat/ *Felis catus* 469, Pig/ *Sus scrofa* 393, Horse/ *Equus caballus* 228, Goat/ *Capra aegagrus* 145 and Pigeon/ *Columbia livia* 141. At the other end of the spectrum, 172 species/categories were mentioned only once or twice (Table 1).

For the humanities, feral was applied to 14 species and 16 more general categories (Table 2). The distribution of mentions was similarly skewed, with the top three species accounting for more than half: Cat/ *Felis catus* 20, 'animals' 18 and Pig/ *Sus scrofa* 11 mentions. 23 species/categories received only a single mention (Table 2). Importantly, feral was not used by humanities scholars in any discussion about the culture of 'feral', as we are

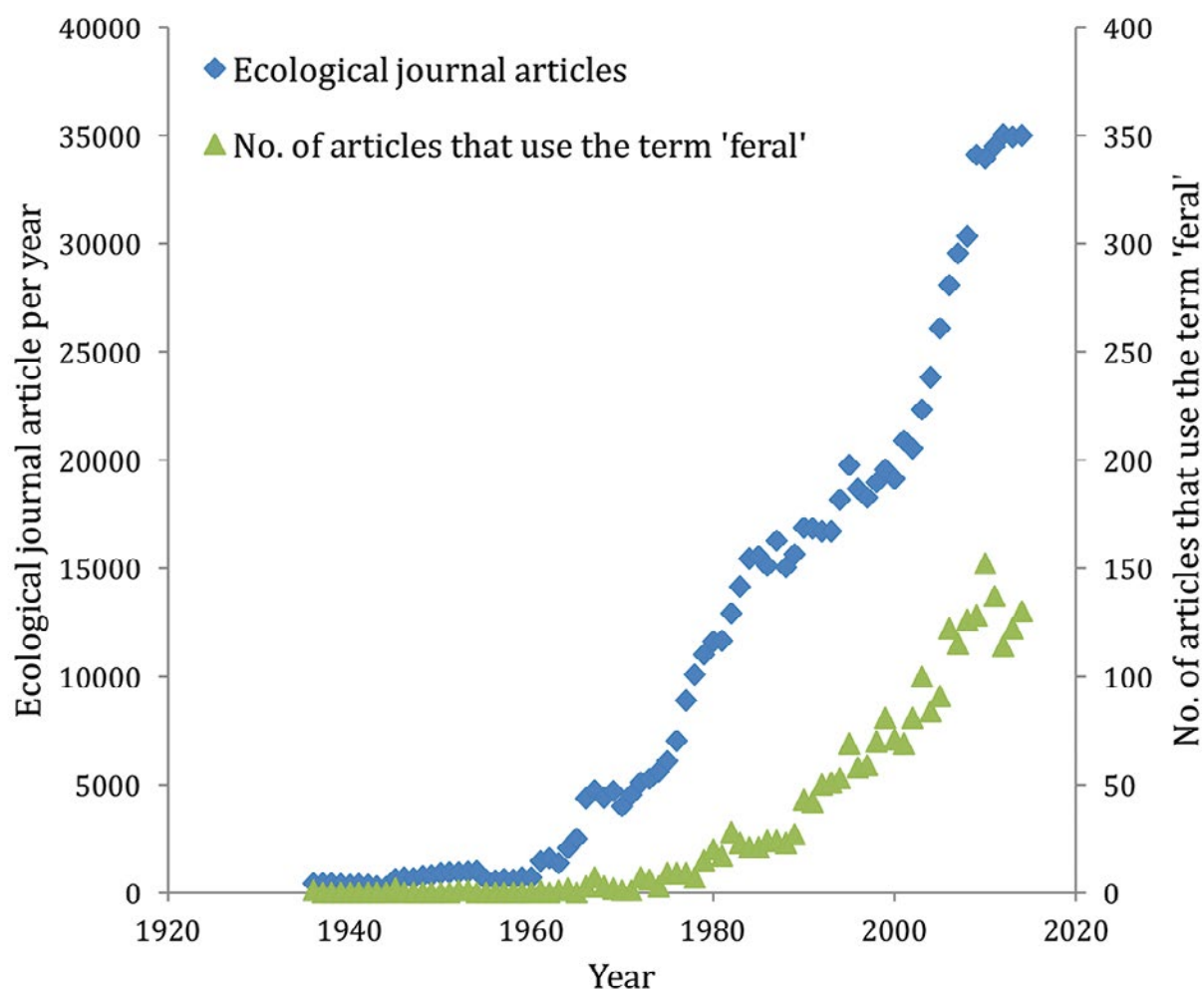


Figure 1. Total ecological articles (scale on the left) and those that use the word 'feral' (scale on the right) per year.

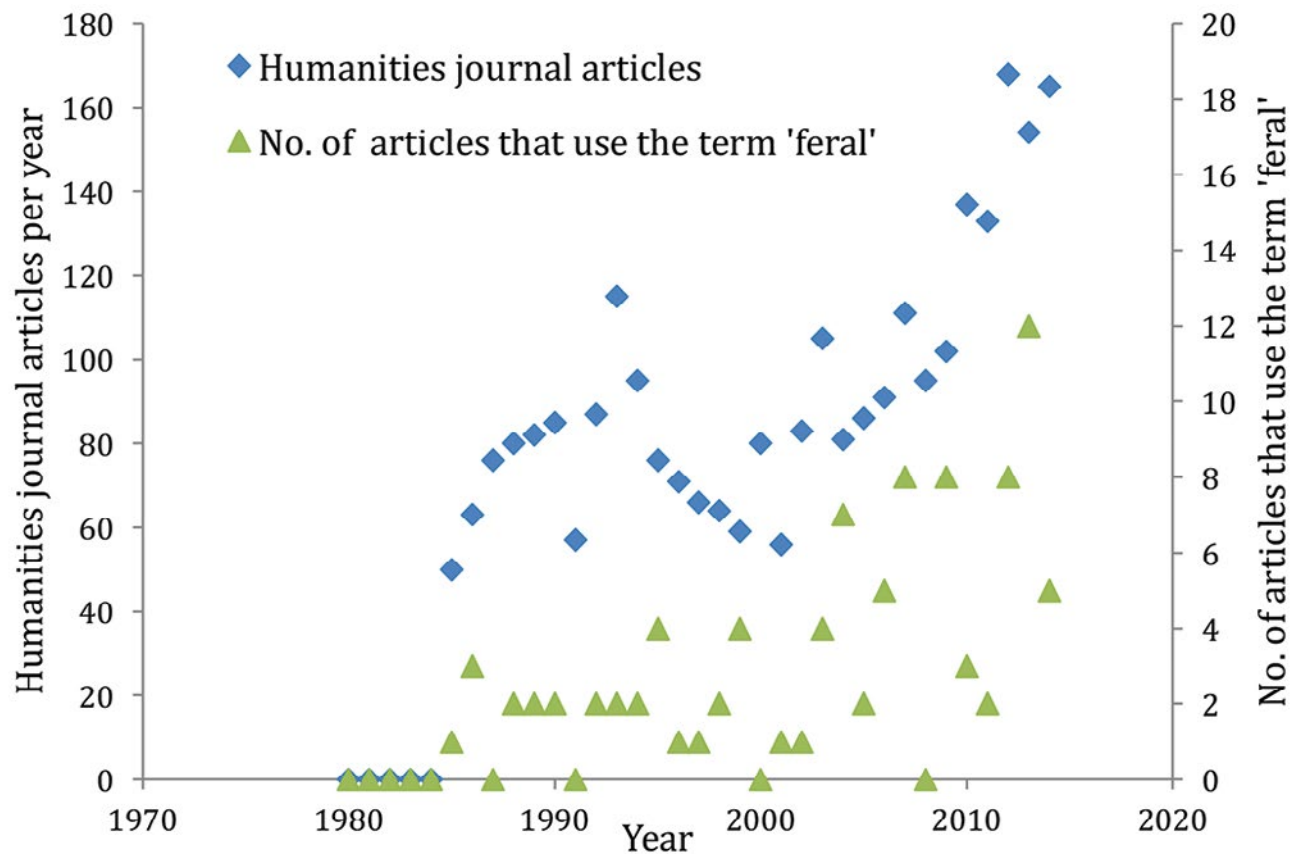


Figure 2. Total humanities articles (scale on the left) and those that use the word 'feral' (scale on the right) per year.

Table 1. Species or other categories which have been deemed 'feral', and the frequency of mentions, in the natural sciences from 1900 until 2014.

Common name	Latin name	Category	Total mentions
Cat	<i>Felis catus</i>	Mammalia	469
Pig	<i>Sus scrofa</i>	Mammalia	393
Horse	<i>Equus caballus</i>	Mammalia	228
Goat	<i>Capra aegagrus (C. hircus)</i>	Mammalia	145
Pigeon	<i>Columbia livia</i>	Aves	141
Mouse	<i>Mus musculus</i>	Mammalia	80
'fish'		Fish	80
American mink	<i>Mustela vison</i>	Mammalia	68
'animals'		Other	66
Dog	<i>Canis lupus familiaris</i>	Mammalia	61
Sheep	<i>Ovis aries</i>	Mammalia	49
Asian water buffalo	<i>Bubalus bubalis</i>	Mammalia	47
Honey bee	<i>Apis mellifera</i>	Insecta	44
Donkey	<i>Equus asinus</i>	Mammalia	36
Oilseed rape	<i>Brassica napus</i>	Plant	28
'predators'		Other	28
Ferret	<i>Mustela putorius</i>	Mammalia	25
Guppy	<i>Poecilia reticulata</i>	Fish	24
Cattle	<i>Bos taurus</i>	Mammalia	23
Dromedary camel	<i>Camelus dromedarius</i>	Mammalia	22
Coypu	<i>Myocastor coypus</i>	Mammalia	15
'ungulate'		Mammalia	14

Common name	Latin name	Category	Total mentions
'population'		Other	14
European rabbit	<i>Oryctolagus cuniculus</i>	Mammalia	13
'Herbivores'		Other	13
'species'		Other	11
Chicken	<i>Gallus gallus domesticus</i>	Aves	10
'mammals'		Mammalia	8
Common carp	<i>Cyprinus carpio</i>	Fish	8
'GM crops'		Plant	8
'livestock'		Mammalia	7
African clawed frog	<i>Xenopus laevis</i>	Amphibia	7
Brown trout	<i>Salmo trutta</i>	Fish	7
'crop plants'		Plant	7
Sika deer	<i>Cervus nippon</i>	Mammalia	6
Mute swan	<i>Cygnus olor</i>	Aves	6
Common peafowl	<i>Pavo cristatus</i>	Aves	6
American bullfrog	<i>Lithobates catesbeianus</i>	Amphibia	6
Red fox	<i>Vulpes vulpes</i>	Mammalia	5
Reeves Muntjac	<i>Muntiacus reevesi</i>	Mammalia	5
Brown rat	<i>Rattus norvegicus</i>	Mammalia	5
Buff-tailed bumblebee	<i>Bombus terrestris</i>	Insecta	5
'Brassica'		Plant	5
Olive tree	<i>Olea europaea</i>	Plant	5
'apes'		Mammalia	4
Raccoon	<i>Procyon lotor</i>	Mammalia	4
Red-eared slider	<i>Trachemys scripta</i>	Testudines	4
Cane toad	<i>Rhinella marina</i>	Amphibia	4
Baltic salmon	<i>Salmo salar</i>	Fish	4
European chub	<i>Leuciscus cephalus</i>	Fish	4
Perch	<i>Perca fluviatilis</i>	Fish	4
'plants'		Plant	4
Brush-tail possum	<i>Trichosurus vulpecula</i>	Mammalia	3
'carnivores'		Mammalia	3
'Deer'		Mammalia	3
Leaping mullet	<i>Liza saliens</i>	Fish	3
Mullet	<i>Liza aurata</i>	Fish	3
Rainbow trout	<i>Oncorhynchus mykiss</i>	Fish	3
Winter flounder	<i>Pseudopleuronectes americanus</i>	Fish	3
Pacific oyster	<i>Crassostrea gigas</i>	Mollusc	3
Soft-shelled clam	<i>Mya arenaria</i>	Mollusc	3
Sunflower		Plant	3
Sugar beet	<i>Beta vulgaris</i>	Plant	3
Wild cabbage	<i>Brassica oleracea</i>	Plant	3
African green monkey	<i>Cercopithecus aethiops</i>	Mammalia	2
Banteng	<i>Bos javanicus</i>	Mammalia	2
Black rat	<i>Rattus rattus</i>	Mammalia	2
Bennetts wallaby	<i>Macropus rufogriseus</i>	Mammalia	2
Common squirrel monkey	<i>Saimiri sciureus</i>	Mammalia	2
Commensal rat	<i>Rattus rattus</i>	Mammalia	2

Common name	Latin name	Category	Total mentions
Cotton rat	<i>Sigmodon hispidus</i>	Mammalia	2
'domestic animals'		Mammalia	2
Orangutan	<i>Pongo pygmaeus</i>	Mammalia	2
Rat sp.	<i>Rattus sp.</i>	Mammalia	2
Reindeer	<i>Rangifer tarandus</i>	Mammalia	2
Small asian mongoose	<i>Herpestes javanicus</i>	Mammalia	2
Tammar wallaby	<i>Macropus eugenii</i>	Mammalia	2
Yellow baboon	<i>Papio cynocephalus</i>	Mammalia	2
Canada goose	<i>Branta canadensis</i>	Aves	2
Mallard / domestic duck	<i>Anas platyrhynchos</i>	Aves	2
Green iguana	<i>Iguana iguana</i>	Reptile	2
Rana ribicunda	<i>Rana ribicunda</i>	Amphibia	2
Benthic amphipod	<i>Diporeia sp.</i>	Crustaceae	2
Red-Claw crayfish	<i>Cherax quadricarinatus</i>	Crustaceae	2
Shore crab	<i>Carcinus maenas</i>	Crustaceae	2
Asian honeybee	<i>Apis cerana</i>	Insecta	2
Beet armyworm	<i>Spodoptera exigua</i>	Insecta	2
Cockroach	<i>Blattaria sp.</i>	Insecta	2
European Corn-borer	<i>Ostrinia nubilalis</i>	Insecta	2
Gypsy moth	<i>Lymantria dispar dispar</i>	Insecta	2
House fly	<i>Musca domestica</i>	Insecta	2
Mosquito	<i>Aedes aegypti</i>	Insecta	2
Rootworm beetle	<i>Diabrotica sp.</i>	Insecta	2
African sharptooth catfish	<i>Clarias gariepinus</i>	Fish	2
European hake	<i>Merluccius merluccius</i>	Fish	2
Fine-spotted flounder	<i>Pleuronichthys cornutus</i>	Fish	2
Goldfish	<i>Carassius auratus</i>	Fish	2
Hornyhead turbot	<i>Pleuronichthys verticalis</i>	Fish	2
Lake trout	<i>Salvelinus namaycush</i>	Fish	2
Mozambique tilapia	<i>Oreochromis mossambicus</i>	Fish	2
Nile tilapia	<i>Oreochromis niloticus</i>	Fish	2
Roach	<i>Rutilus rutilus</i>	Fish	2
Alfalfa	<i>Medicago sativa</i>	Plant	2
Apple tree	<i>Malus domestica</i>	Plant	2
Rice	<i>Oryza sativa</i>	Plant	2
Creeping bentgrass	<i>Agrostis stolonifera</i>	Plant	2
'grazing'		Other	2
'conditions'		Other	2
A monkey		Mammalia	1
Asian macaque		Mammalia	1
'canids'		Mammalia	1
Common vole	<i>Microtus arvalis</i>	Mammalia	1
Coatimundi	<i>Nasua nasua</i>	Mammalia	1
Crab-eating macaque	<i>Macaca fascicularis</i>	Mammalia	1
European beaver	<i>Castor fiber</i>	Mammalia	1
European otter	<i>Lutra lutra</i>	Mammalia	1
fallow deer	<i>Dama dama</i>	Mammalia	1
Fulvous harvest mouse	<i>Reithrodontomys fulvescens</i>	Mammalia	1

Common name	Latin name	Category	Total mentions
Grey-tailed vole	<i>Microtus canicaudus</i>	Mammalia	1
Guinea pig	<i>Cavia porcellus</i>	Mammalia	1
Koala	<i>Phascolarctos cinereus</i>	Mammalia	1
Langur monkey	<i>Semnopithecus entellus</i>	Mammalia	1
Lion-tailed macaque	<i>Macaca silenus</i>	Mammalia	1
Macaque	<i>Macaca spp.</i>	Mammalia	1
Malayan Wood-rat	<i>Rattus tiomanicus</i>	Mammalia	1
'mammalian herbivores'		Mammalia	1
Muskrat	<i>Ondatra zibetica</i>	Mammalia	1
Old-field mice	<i>Peromyscus polionotus</i>	Mammalia	1
Olive baboon	<i>Papio anubis</i>	Mammalia	1
Owl monkey	<i>Aotus sp.</i>	Mammalia	1
Polar bear	<i>Ursus maritimus</i>	Mammalia	1
Rhesus Macaque	<i>Macaca mulatta</i>	Mammalia	1
'Rodent'		Mammalia	1
Sooty Mangabay	<i>Cercocebus atys</i>	Mammalia	1
Squirrel	<i>Funambulus pennantii</i>	Mammalia	1
Tamarin	<i>Saguinus sp.</i>	Mammalia	1
Tufted capuchin	<i>Cebus apella</i>	Mammalia	1
Vervet monkey	<i>Chlorocebus pygerythrus</i>	Mammalia	1
Yellow-necked mouse	<i>Apodemus flavicollis</i>	Mammalia	1
'birds'		Aves	1
Black vulture	<i>Coragyps atratus</i>	Aves	1
Egyptian goose	<i>Alopochen aegyptiaca</i>	Aves	1
Emu	<i>Dromaius novaehollandiae</i>	Aves	1
Guinea fowl	<i>Numida meleagris</i>	Aves	1
Monk parakeet	<i>Myiopsitta monachus</i>	Aves	1
Rose-ringed parakeet	<i>Psittacula krameri</i>	Aves	1
Ruddy duck	<i>Oxyura jamaicensis</i>	Aves	1
Sacred ibis	<i>Threskiornis aethiopicus</i>	Aves	1
'Reptiles'		Reptile	1
A turtle	<i>Trachemys scripta</i>	Testudines	1
Common tree frog	<i>Polypedates leucomystax</i>	Amphibia	1
Shrimp	<i>Caridina nilotica</i>	Crustaceae	1
Common octopus	<i>Octopus vulgaris</i>	Octopoda	1
An asian honeybee	<i>Apis dorsata</i>	Insecta	1
An asian honeybee	<i>Apis florea</i>	Insecta	1
A beetle	<i>Agriotes lineatus</i>	Insecta	1
A beetle	<i>Agriotes proximus</i>	Insecta	1
A parasitoid wasp	<i>Ascogaster quadridentata</i>	Insecta	1
Brown locust	<i>Locusta pardalina</i>	Insecta	1
Codling moth	<i>Cydia pomonella</i>	Insecta	1
Corn earworm	<i>Helicoverpa zea</i>	Insecta	1
Emerald Ash Borer	<i>Agrilus planipennis</i>	Insecta	1
Italian locust	<i>Calliptamus italicus</i>	Insecta	1
Lesser date moth	<i>Batrachedra amydraula</i>	Insecta	1
'Leaf roller'		Insecta	1
Meadow grasshopper	<i>Chorthippus parallelus</i>	Insecta	1

Common name	Latin name	Category	Total mentions
Moroccan locust	<i>Dociostaurus maroccanus</i>	Insecta	1
Smoky tetanolita moth	<i>Tetanolita mynesalis</i>	Insecta	1
Sweet potato weevil	<i>Cylas formicarius</i>	Insecta	1
Vine mealybug	<i>Planococcus ficus</i>	Insecta	1
American plaice	<i>Hippoglossoides platessoides</i>	Fish	1
Arctic charr	<i>Salvelinus alpinus</i>	Fish	1
Bigmouth sole	<i>Hippoglossina stomata</i>	Fish	1
Blackspot seabream	<i>Pagellus bogaraveo</i>	Fish	1
Capelin	<i>Mallotus villosus</i>	Fish	1
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	Fish	1
Common two-banded seabream	<i>Diplodus vulgaris</i>	Fish	1
Eelpout	<i>Zoarces viviparus</i>	Fish	1
Elizabeth river killifish	<i>Fundulus heteroclitus</i>	Fish	1
English sole	<i>Pleuronectes vetulus</i>	Fish	1
European Sea Bass	<i>Dicentrarchus labrax</i>	Fish	1
Flounder	<i>Platichthys flesus</i>	Fish	1
Gizzard shad	<i>Dorosoma cepedianum</i>	Fish	1
Herring	<i>Clupea harengus</i>	Fish	1
Largemouth bass	<i>Micropterus salmoides</i>	Fish	1
Mosquitofish	<i>Gambusia holbrooki</i>	Fish	1
Mottled sculpin	<i>Cottus bairdii</i>	Fish	1
Red drum	<i>Sciaenops ocellatus</i>	Fish	1
Red mullet	<i>Mullus barbatus</i>	Fish	1
Red scorpionfish	<i>Scorpaena scorpa</i>	Fish	1
Sand lance	<i>Ammodytes sp.</i>	Fish	1
Sand smelt	<i>Atherina presbyter</i>	Fish	1
Senegal sole	<i>Solea senegalensis</i>	Fish	1
Sharp-toothed catfish	<i>Clarias gariepinus</i>	Fish	1
Spottail shiner	<i>Notropis hudsonius</i>	Fish	1
Tub gurnard	<i>Trigla lucerna</i>	Fish	1
Walleye	<i>Sander vitreus</i>	Fish	1
White sucker	<i>Catostomus commersoni</i>	Fish	1
Yellowtail flounder	<i>Pleuronectes ferruginea</i>	Fish	1
A mussel	<i>Elliptio complanata</i>	Mollusca	1
Asian clam	<i>Potamocorbula amurensis</i>	Mollusca	1
'bivalve shellfish'		Mollusca	1
Freshwater mussel	<i>Elliptio complanata</i>	Mollusca	1
Great pond snail	<i>Lymnaea stagnalis</i>	Mollusca	1
Land snail	<i>Discus rotundatus</i>	Mollusca	1
Land snail	<i>Oxychilus draparnaudi</i>	Mollusca	1
'marine bivalves'		Mollusca	1
	<i>Corbicula</i>	Mollusca	1
European eel	<i>Anguilla anguilla</i>	Anguilliformes	1
Vericonellid slugs	<i>Vericonellidae</i>	Platyhelminthidae	1
Hammerhead slug / land flatworm	<i>Bipalium kewense</i>	Platyhelminthidae	1
'forests'		Plant	1
Rye	<i>Secale cereale</i>	Plant	1

Common name	Latin name	Category	Total mentions
'aquatic macrophytes'		Other	1
'aquatic organisms'		Other	1
'benthic invertebrates'		Other	1
'habit'		Other	1
'farmed organisms'		Other	1
'Invertebrate Biological Control Agents'		Other	1
'fire'		Other	1
'landscape'		Other	1
'microalgal populations'		Other	1
'organism'		Other	1
'pets'		Other	1
'pollution'		Other	1
'prey'		Other	1
'stands'		Other	1
'teleosts'		Other	1

Table 2. Species or other categories which have been deemed 'feral', and the frequency of mentions, in the humanities from 1980 until 2014.

Common name	Latin name	Category	Total mentions
Cat	<i>Felis catus</i>	Mammalia	20
'animals'		Other	18
Pig	<i>Sus scrofa</i>	Mammalia	11
Dog	<i>Canis lupus familiaris</i>	Mammalia	7
'children'		Other	4
'species'		Other	4
Cattle	<i>Bos taurus</i>	Mammalia	3
Goat	<i>Capra aegagrus</i>	Mammalia	2
Sheep	<i>Ovis aries</i>	Mammalia	2
'agent'		Other	2
'population'		Other	2
Asian water buffalo	<i>Bubalus bubalis</i>	Mammalia	1
Banteng	<i>Bos javanicus</i>	Mammalia	1
Donkey	<i>Equus asinus</i>	Mammalia	1
Human	<i>Homo sapiens</i>	Mammalia	1
Horse	<i>Equus caballus</i>	Mammalia	1
Mouse	<i>Mus musculus</i>	Mammalia	1
Reindeer	<i>Rangifer tarandus</i>	Mammalia	1
Pigeon	<i>Columbia livia</i>	Aves	1
'butterfly'		Insecta	1
'counterparts'		Other	1
'gone'		Other	1
'look'		Other	1
'pest'		Other	1
'state'		Other	1
'world'		Other	1

doing here. It was used, as in the natural sciences to label particular species, groups or behaviours.

Within the natural sciences, 236 species or categories were considered feral, with both the total number of species and accumulation rates varying markedly between taxonomic groups (Figure 1). In 1945, mammals became the first group to have been referred to as feral. Over the entire time period, 64 identifiable mammal species have been considered feral however there have been no new feral mammal species since 2009. Fish are the next most common category with 57 species considered feral before 2014. Their rise has been more recent, with the first fish considered feral only in 1985 (Figure 3). In our selection of animal studies papers, all identifiable species were mammals (13 species), except for one bird (pigeon) and one insect (butterfly).

For the two most mentioned species in the natural sciences, the cat and pig, graphs of the relative frequency of being called feral showed similar results (Figures 4 and 5 respectively). For both species, the total number of mentioned has increased from the mid-1960s until the present time, with a few fluctuations along the way. For cats, the percentage of mentions which include 'feral' has developed in a step-wise fashion in proportion to the total cat research output – there appears to have been an initial

burst of feral cat research in the late 1970s and early 1980s, and then another major burst in the late 1990s. Apart from these periods, feral cat mentions have proportionally kept pace with total cat mentions. This is similar for pigs. They have a smaller overall percentage, but also a proportional increase of 'feral' pig mentions in the early 1980s and a smaller, second increase in the mid-2000s.

Discussion

The first reference to feral in either canon, was in 1936, when albino and spotted rats (*Rattus norvegicus*) were recorded living under 'feral conditions' (Svihla 1936). More specifically, these were pets that had escaped and subsequently adapted themselves to the natural conditions found on Lanai, an island south of Hawai'i. In the same paper, the author also commented on the 'feral domestic cats' of the island, although no more details were given about their situation (Svihla 1936). In both cases, the individuals were feral because they were domestic species living under natural conditions, but not from the local nature, echoing the idea of feral being considered as not legitimately part of the natural ecosystems which they inhabit (Bhattacharyya *et al.* 2011). In fact, all of the top five species/groups that

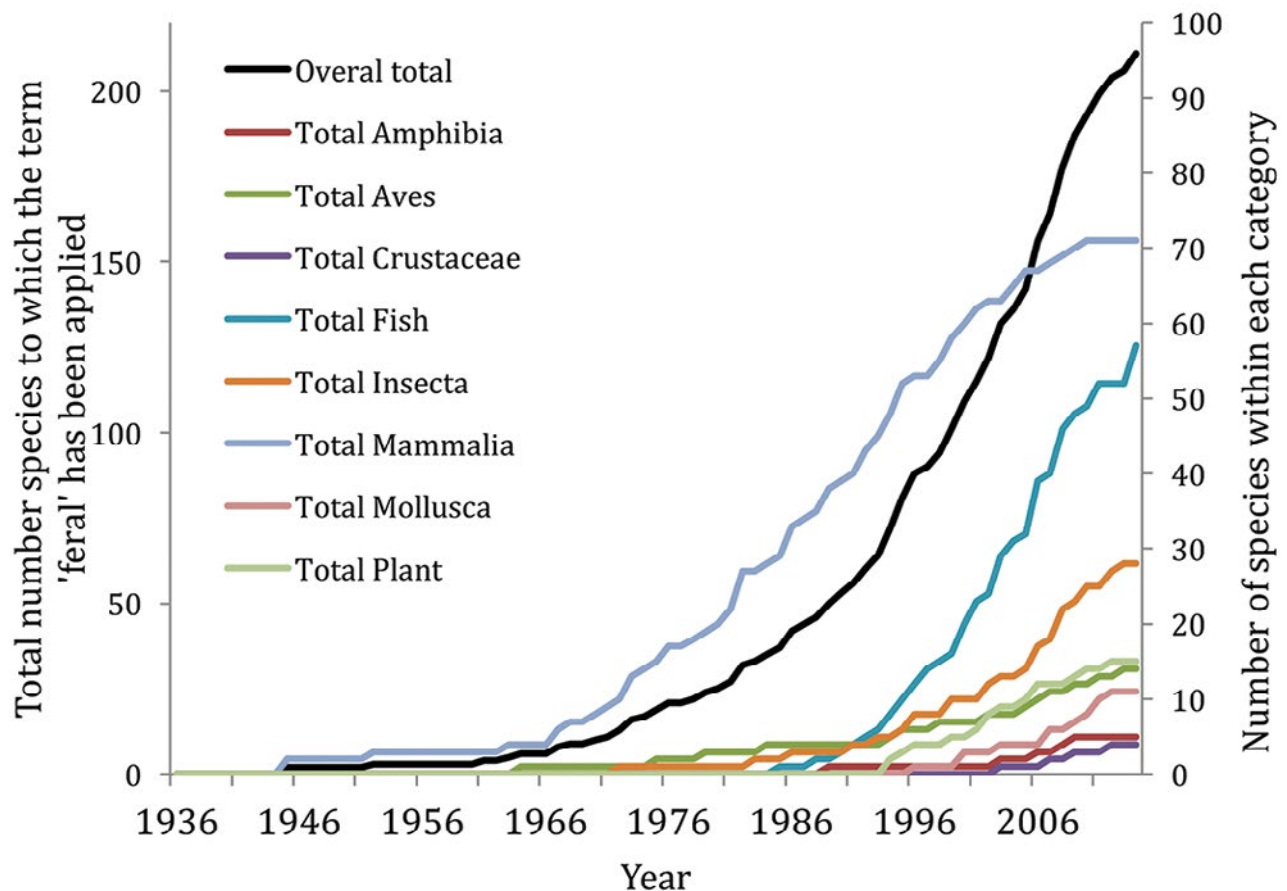


Figure 3. The cumulative number of species in each higher-level category to be considered feral, take from records of the Web of Science from 1900 until 2014. Taxonomic groups with only two mentions (Platyhelminths, Testudines and Reptiles) have been excluded from this graph for clarity.

were regularly labeled 'feral', cats, pigs, horses, goats and pigeons were formerly domesticated and later wild. This applied to the majority of species in all journals surveyed.

The natural sciences tended to concentrate on species that have the greatest perceived impact on the 'natural' environment, reflecting a deep care for all that is 'native' or naturally 'wild' and a desire to protect this wild nature. Cats are perhaps the most commonly blamed feral animal, as they have been devastating predators and have been implicated in the decline and extinction of many animal species worldwide (Medina *et al.* 2011). Pigs are responsible for causing population declines in at least 268 species (Gurevitch and Padilla 2004), but in addition to being predators, their impact also comes from damaging vegetation and watercourses. Horses and goats cause habitat damage, rather than directly eating small mammals. This explains something of the popularity of these groups to natural science studies. The prominence of the pigeon is interesting: it does not fit into the same story as its impact is not in the 'wild', but in the most human of environments. Pigeons are discussed with other birds below.

Some species appear particularly high in the table due to a well-studied single population, or small number of

small populations. Although this would not significantly change the order of the most mentioned species, for species with fewer mentions it can have a large effect. For example, many of the feral guppy records come from studies of a single population in Japan, while many of the feral sheep records are from well-studied populations on Santa Cruz Island, California and Soay, the Scottish island. The sheep studies raise complex issues about the interests of pastoralism versus 'nature conservation', de-domestication and re-domestication (Woods forthcoming). Most of the Santa Cruz sheep were culled to protect nature, and now the small herd is conserved ('domesticated') for its genetic diversity. It is striking that 'feral' in this case is not pejorative, merely the opposite of 'domesticated' or simply 'neglected by humans'. This way of using 'feral' dates back to the nineteenth century:

'Domesticated individuals are continually escaping from man's control, and founding races of their own, which thus are trying back again when left to their mutual selection, as it were, to re-found the old primal stock from which they were in remote ages derived. These new races are called feral, to distinguish them from the original wild stock' (Gilpin 1867: 60)

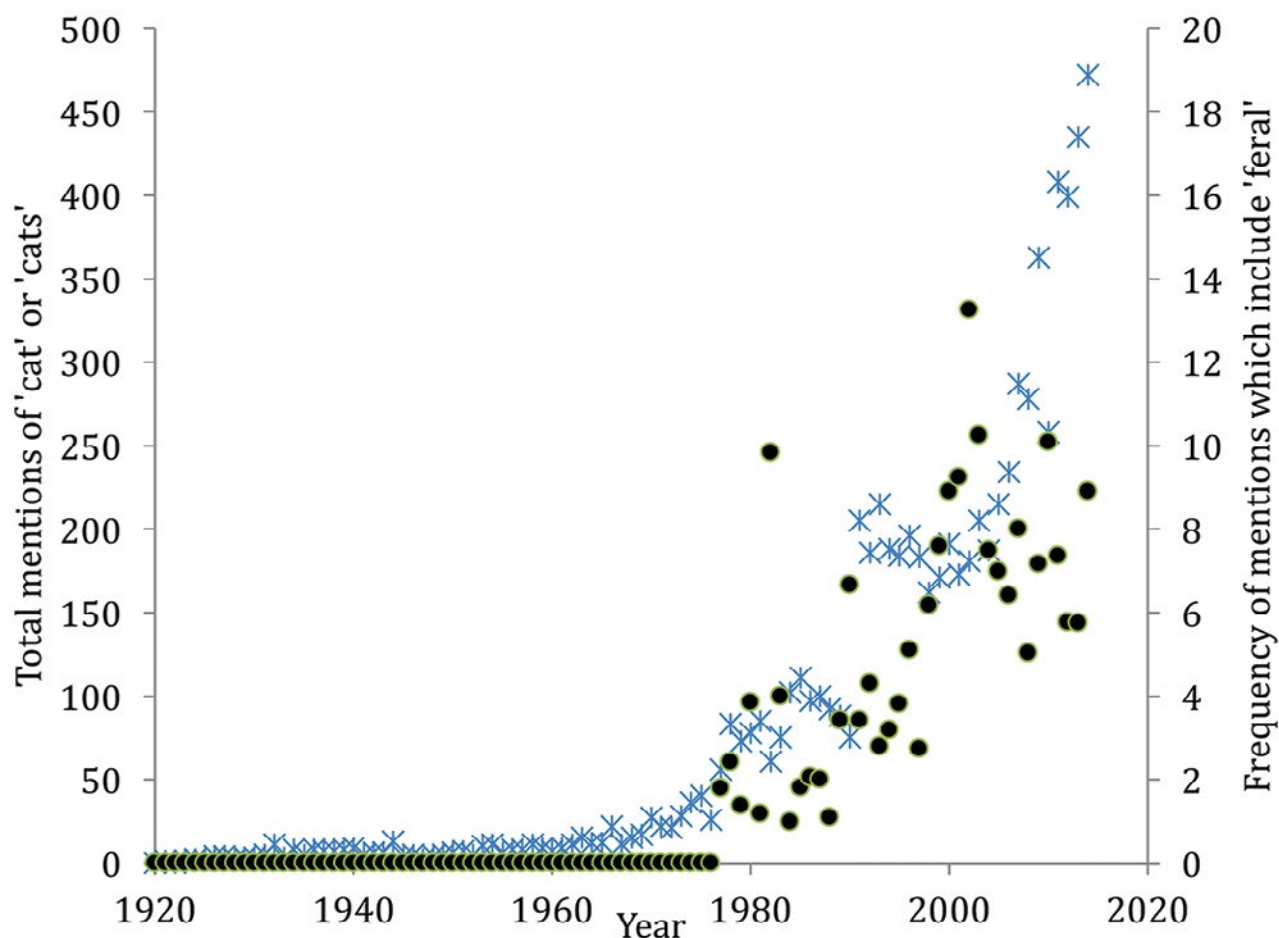


Figure 4. Comparison of references to 'cat' or 'cats' with and without feral in records of the Web of Science between 1920 and 2014. Blue crosses – total mentions, black dots – percentage of mentions.

Species coverage

As expected, mammals dominated both literatures because of humans' long inter-relationship with them, and the worldwide distribution of the common domesticated species. Perhaps the fact that Invasion Biology is led by zoologists (following Elton) rather than botanists, is also relevant (Richardson 2011). The long history of domestication has created opportunities for 'de-domestication', particularly where animals are deliberately moved to create new settler societies (Griffiths and Robin 1997). The range of mammal species (both large and small, carnivores and herbivores) and the huge effects they can have on ecosystems (e.g. McNaughton *et al.* 1988; Medina *et al.* 2011) has led to a huge number of studies in the natural sciences. Similarly, our very close relationship with at least a few mammals (especially dogs) (Hart 1995) is reflected in the high number of mentions of these species in the humanities, perhaps because studies explore *human* intimacy and emotional relations with animals (often in urban settings), rather than economic or biodiversity concerns in broad-scale landscapes.

While the number of mammals described as feral seems to have plateaued, this does not appear to be the case for any other species group (Figure 3). Is the original mammalian 'feral' now working for other biota? Some changing perceptions of 'feral' are reflected in our data.

The rapid increase in the number of species to which feral applies has shown no signs of slowing down in the last few years (Figure 3), and new feral populations of many species become apparent as global trade networks and surveillance increases. On the other hand, the natural history literature maintains steady interest in feral cats and pigs, perhaps the archetype 'ferals' that provide the basis for extending the term to other species out of control? These reflect an attitude that has been so constant (Figures 4 & 5) that there is perceived political safety in Threatened Species Management leading with culling feral cats, as announced by the Australian Government on 16 July 2015 (DotE 2015). A plan that focused, for example, on culling kangaroos or horses, both of which have been deemed 'feral' by some nature conservation groups (Blucher and Brown 2014; ABC 2015) would have been much more politically controversial. The term 'feral' for a native species is used by Olsen (1998) for native animals 'that have been moved to new habitats'. In this case the human agency is indirect: the animals have moved from drought stricken pastoral country to urban areas where there is water, and they are only 'alien' in the sense they are in the wrong bioregion, not the wrong country (see Chew and Hamilton 2011).

The labeling of birds as 'feral' reveals the complexity of issues associated with the term. Feral birds are dominated by the pigeon, a species that Darwin considered feral

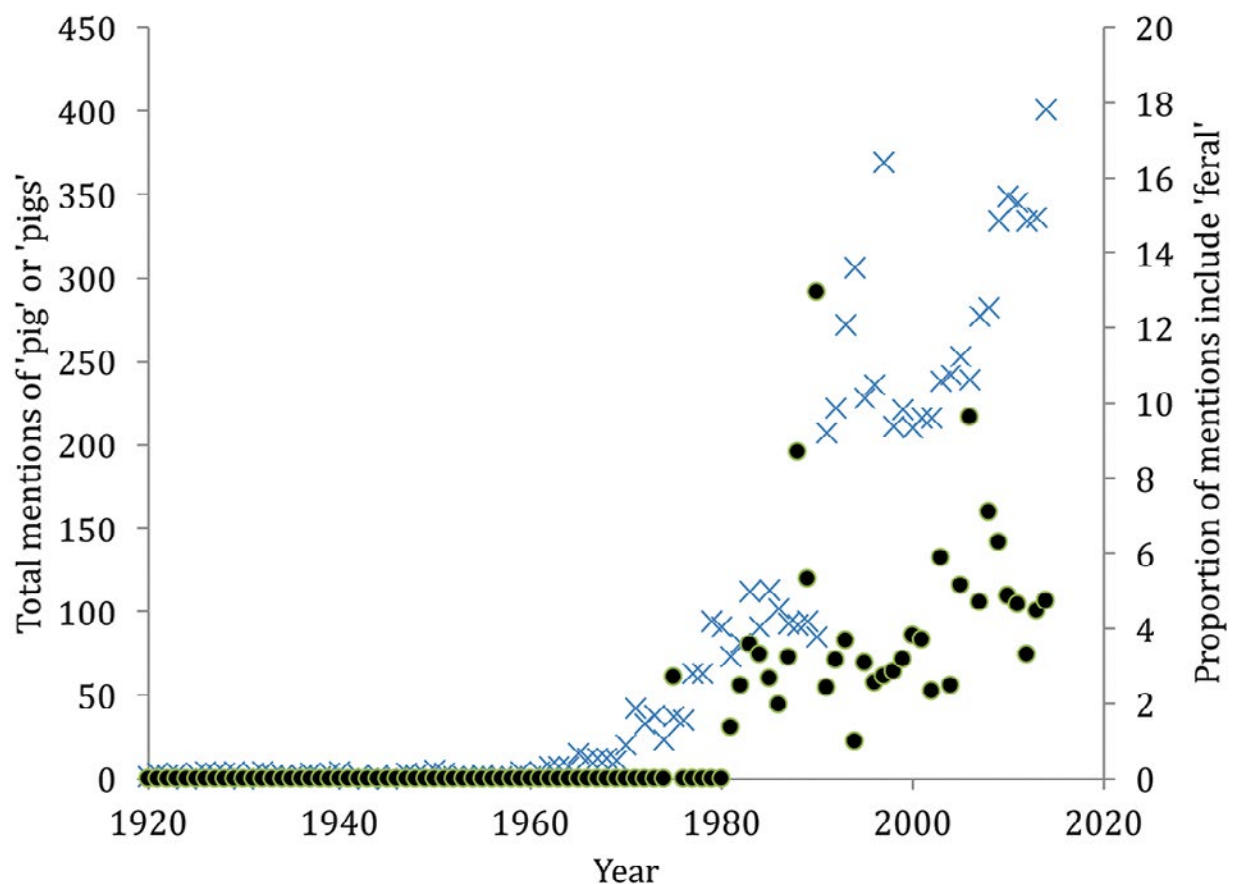


Figure 5. Comparison of references to 'pig' or 'pigs' with and without feral in records of the Web of Science between 1920 and 2014. Blue crosses – total mentions, black dots – percentage of mentions.

(Darwin 1872), and with a worldwide distribution matching those of human-dense areas. While they have been de-domesticated, we believe that the interest in pigeons is higher than other birds because of their potential to carry diseases that affect both humans and livestock (Haag-Wackernagel and Moch 2004) and because they damage the aesthetics of urban areas. Pigeons are clearly de-domesticated, and hence are legitimately considered feral in that sense. But then there are lots of pet species and other introductions that have established 'feral' populations (for a thorough review see Long 1981), but few are called feral – why is this so? Does human perception require more than just presence – does it require agency too? So perhaps pigeons are feral, not because they have been de-domesticated, but because they behave in a certain way, soiling the human environment and disturbing the human-controlled order, inhibiting domestication in urban environments? The fact that pigeons are mentioned 10 times more frequently than any other bird species is only partly explained by the fact that this bird is common and easy to identify, where others are not. Importantly, 'feral' pigeons have been used to study a wide range of diseases that affect humans (Haag-Wackernagel and Moch 2004), however other species with escaped populations which also carry human-threatening disease (e.g. parrots/ *psittacosis*) are not considered feral. So it appears that risk to human health is not a sufficient reason in itself to label something feral.

Agricultural vs Biodiversity contexts

The term feral is not the only negative adjective that has been applied to creatures by those working with them, practically or philosophically. For most of the 20th century, nuisance animals were referred to as 'pests' and 'vermin', and were deemed nuisances because they damaged agriculture or introduced human disease, not because they interfered with biodiversity. The state of Victoria in Australia, had a Vermin and Noxious Weeds Destruction Board from 1958-1984, when it was replaced by a Land Protection Agency (PROV undated). The 'noxious' focused on agricultural weeds, rather than plants rampantly out of control, and 'land protection' continued this tradition. Pest species themselves were not labeled without a clear awareness of what or who was troubled. Vermin was most often used in the context of cities and built environments. The original vermin was the rat that carried bubonic plague, and the defense against rats on ships was the cat. In this sense the cat is the classic 'feral' introduced to help humanity, and then becoming all too successful, and changing the world in its wake (Elton 1958). 'Ecological imperialism' was a major partner in the spread of European 'civilization' to the New World and other settler societies (Crosby 1986; Griffiths and Robin 1997).

The idea of 'invasive' species came to prominence in the 1980s alongside the new term 'biodiversity' (Farnham 2007) with the rise of invasion biology and conservation

biology as crisis science (Soulé 1985). Theodoropoulos (2003) responds to this debate by arguing that invasion by ferals is a symptom of a disturbed ecosystem, not a cause, and this view and others like it may account for the levelling of mentions of 'feral' after about 2006. 'Invasion biology' reflected a particular care for wild nature, and it created a new pejorative niche for the word 'feral', although the concept had been around since the *Origin of Species*. Darwin referred to pigeons and cattle, and even horses and dogs as 'feral' (Darwin 1859: 87). It was clearly a new term then, as Darwin included a definition of feral in his glossary to subsequent editions (see epigraph to this paper, Darwin 1872).

The rise of feral plants

In his definition of feral, Darwin (1872) applied the term equally to both plants and animals – 'cultivation or domestication' is unequivocally inclusive of both groups. On the contrary, our data show that plants were not described as feral until 1994 (Table 1). These findings are supported by a review of the terminology of plant invasions up until 1993 which did not include the word/concept feral (Pyšek 1995). Contexts of ferality have varied over time, but it is now more in vogue than ever before. The question remains about why 'feral' disappeared from the plant lexicon, only to reappear again more recently.

While Darwin used 'feral' and 'domesticated' as opposites, and the latter has been in continuous use since (for example by the Global Crop Diversity Trust 2015), feral appears to have been lost and rediscovered. The new term feral seems to apply to plants associated with human manipulations *beyond* domestication, for example with genetically modified organisms (GMOs) and food crops. It is about active human intervention, not just selection for characteristics. Oilseed rape or canola *Brassica napus* was first approved for commercial cultivation in Canada in 1995 (Bauer-Panskus and Then 2013), the year after the first application of feral to plants, and same year that the species was first described as 'feral' (Table 1). This species has been described in 28 different articles as feral, and there are a further 8 mentions of 'genetically modified crops' supporting this idea. Plants are understood differently in agricultural and biodiversity contexts. Lesley Head and colleagues argue that plants like wheat have become so much agricultural commodities that we have forgotten their 'plantiness'; extensive fields of wheat have even been omitted from standard vegetation maps of Australia (Head *et al.* 2012).

Popular and technical feralities

From the perspective of settler societies like Australia and New Zealand, where, as farmer-historian Eric Rolls (1969) expressed it, 'They All Ran Wild', we were struck by how few scientific studies described rabbits, camels or possums as 'feral'. Oilseed rape, guppies and honeybees were all more highly mentioned as 'feral' than rabbits, even though these are classic ferals in the sense that

they are formerly domesticated mammals gone wild and breeding up in large numbers, and having a high nuisance value. A search of the same set of journal for 'rabbits' without the 'feral' label revealed 6700 results. Only 13 of these were 'feral rabbits'. Perhaps this reflects the shift towards virological solutions to the rabbit problem (myxomatosis, Rabbit Haemorrhagic Disease) and the shift by CSIRO away from 'Wildlife Survey' to 'Rangelands Management' in the 1980s, classifying the rabbit work as 'agricultural' rather than 'biodiversity' science, in today's terms. Ferality, it seems, is now about biodiversity nuisance, not primary industry problems.

Categories of nuisance

Given this large list of species that have, at one stage, been considered 'feral', what conclusions can we draw as to the meaning and use of 'feral' in the natural sciences and humanities literatures from this study? There are three main categories of species that have been considered feral:

Populations of species that have been domesticated at some stage in the past and have since become de-domesticated. Darwin's original definition (Darwin 1872) still holds true for many applications of the term in all journals surveyed. It is certainly the dominant use of the term in current literature.

Those species, populations or individuals that are feral because they are in the wrong place, but have never been domesticated.

Movement to this new place could be natural invasion, or, more commonly through human-mediated movement. This applies to many of lesser-mentioned species, particularly the fish and invertebrate species, in both Table 1 and Table 2.

Those species, populations or individuals which are feral because of their behaviour.

This is a rather small category but it is conceptually interesting. The fact that it is so small suggests changing use of the word 'feral' itself. Unlike the words 'nuisance' and 'pest', used historically for creatures whose behaviour was a problem for agriculture, feral is often a more generalized pejorative. It is morally laden and lays the blame with the feral species itself. When feral is used to describe behaviour, it usually applies to a specific population (often monkeys) or individuals (a rogue polar bear in Churchill, Manitoba) who are behaving unnaturally or causing risk for humans. In the case of the feral polar bear, it was in its natural habitat, but its behaviour had altered in response to the presence of humans and towns (Leatherland and Ronald 1981). These bears are typically found 'in the dump, in town, damaging property, and/or threatening life' and are now more correctly identified as 'problem' bears (Towns *et al.* 2009).

The question of changing behaviour in the presence of humans is most striking in the case of the feral cat.

Bryant described the ferality of a cat as the degree of contact and control a given cat will readily accept from humans: 'cats exhibit temperaments that range from completely docile and trusting to totally human-avoidant' (Bryant 2013: 125). There are some who write of 'semi-feral' cats (for example, Baker *et al.* 2010) But the feral spectrum does not include indoor cats, which behave at the docile end of the spectrum when they are with their human families, but at the opposite end of the spectrum when in frightening or novel situations such as animal shelters or veterinary clinics. Outdoor cats are equally difficult to categorize. Free-roaming human-appreciating cats, who may spend chunks of time indoors with human families, may look the same as free-roaming completely human-avoidant cats. Moreover, completely tame cats can 'go feral', and the offspring of completely feral cats can be tamed if they receive socialization by humans before they reach the age of 3 months. Thus, the categories of feral and non-feral cats are fairly fluid, except that in the popular imagination, the first is a 'bad' cat and the latter is a 'good' one. That fluidity also confers more protection to cats than if the categories of feral and non-feral cats were distinct, with feral cats being treated as wild animals such as raccoons and squirrels, easily characterized as 'pests' (Bryant 2013). An unconscious preference for the domesticated sets the framework for judging all animals, and this prejudice colours management approaches to feral animals.

In general, the use of feral as a descriptor is on the rise. While this meaning of the term feral has been applied to a range of animals from all major groups, it has also been applied to a range of less tradition categories as well. For instance, Schnitzler *et al.* (2011) considered some landscapes in France 'feral' or 'de-domesticated' as they were once cultivated and then abandoned. Importantly, the authors argue that these feral landscapes could never return to a 'pristine' or 'wild' state because succession processes will follow a different path than truly wild areas due to the new environmental factors and novel species assemblages in the new place (Schnitzler *et al.* 2011).

Conclusions: Feral Futures

The use of the word 'feral' often reveals more about the human management of the environment than about the animal itself. Being feral is about being beyond human control. As one Australian coastal manager put it: 'We do not manage the environment, only the human behaviours that affect its structure and processes' (Kenchington 1994).

This study found broad consistency between the natural sciences and humanities disciplines in their meaning of the term *feral*, and the species or concepts to which it was applied, despite the very different approaches,

purposes and perceptions of nature that the journals represented. The natural sciences tended to group animals as a group, population or species on an ecosystem scale, while the humanities typically treated animals or plants as individuals. This affected the ethics of human-animal relations, but not the moral import and stigma of ferality. Mentions of 'feral' were proportionally an order of magnitude more common amongst animal studies scholars, predominantly concerned about the ethics of human relationships with individuals of a species.

The title for this final section is borrowed from Tim Low, whose book *Feral Future* (1999) grapples with the question of managing exotic environmental weeds in Australia from an ecological perspective. Coining a neologism, he feared the 'Homocene', where 'the richness of planetary life will give way...to a simplified series of homogenous ecosystems' (Low 1999: 237), apparently unconscious that the entomologist Michael Samways defined a similar term "Homocenocene" about the same time (Kolbert 2014: 107). One of us (LR) was part of a team writing an interdisciplinary paper on the cultural construction of *Acacia*, including *A. pycnantha* (Golden wattle), an invasive environmental weed in South Africa, and the national floral emblem of Australia (Carruthers *et al.* 2011). We had described 'biodiversity' as a *cultural* concept in our paper and shown how its uses had changed historically. In correspondence, Low denied that this was possible, arguing that 'biodiversity' was easily measured and therefore entirely objective, and timeless. This position, that biodiversity is a 'measurable, scientific' concept, and therefore could never also be cultural, is something that the idea of nature in the Anthropocene turns on its head.

Ferality is an important concept for the future, indeed if Low's Homocene comes about, there will be fewer species, but all of them more out of control. The crucial value of a study like this is to unpack some of the cultural baggage it carries alongside it. The notion of ferality co-defines our understanding of threatened species, invasive species, conservation and even, perhaps, the new nature of the Anthropocene. Yet it is only recently was there a separation of *feral* from *wild*, with the latter being morally superior. This distinction is not useful, unless

the feral animals are not legitimately part of the natural ecosystems which they inhabit or frustrating attempts to conserve other species or to recreate a landscape (Shelton 2004; Bhattacharyya *et al.* 2011).

The rise in use of the term *feral* has been accompanied by a rise in expertise in invasion biology, and has a close alliance with the particular late twentieth-century environmental activism around biodiversity, rather than agriculture. It reflects a break from the earlier history of feral meaning simply 'undomesticated', which was the language of managing nature for agricultural and pastoral economies more typical of the first six decades of the century.

This study suggests that future publications need to be clear about the definition and application of the term *feral* to ensure consistency across disciplines, and are as explicit as possible about its natural and social context. The negative moral overtones attached to feral behaviour in popular understanding suggest that feral would be better not used in technical literature in future for rogue individuals, especially when they are members of a vulnerable species like polar bears.

Is *feral* a valid or useful term? Perhaps, amidst growing awareness of the idea of 'novel ecosystems' (e.g. Hobbs *et al.* 2006; Marris 2011) and the Anthropocene, it would seem redundant. Everything in novel ecosystems is, by definition, equally out of place. Whether or not a species was previously domesticated is of historical interest only, and perhaps not useful in informing of management decisions. Preserving the concept of ferality implies that it is realistic to fix targets for preserving historic ecosystems at some historical moment. If however, the point is to manage existing and newly emerged ecosystems for their own sake, we may see a decline in the use of the pejorative *feral*.

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References

- ABC. 2015. Canberra kangaroo culling: contraceptive dart trial could end controversy. <http://www.abc.net.au/news/2015-03-17/contraceptive-darts-could-end-roo-culling-controversy/6324286>. Accessed on 16 August 2015.
- Baker, P. J., C. D. Soulsbury, G. Iossa and S. Harris 2010. Domestic cat *Felis catus* and domestic dog *Canis familiaris*. In *Urban Carnivores: Ecology, Conflict and Conservation* (Eds. S.D. Gehrt, S.P.D. Riley, B.L. Cypher) Baltimore, Johns Hopkins University Press: 157–172.
- Bauer-Panskus, A., and C. Then. 2013. *Transgene escape: genetically engineered oilseed rape out of control - a global perspective*. Testbiotech e.V.: Pp. 16.
- Bhattacharyya, J., S. Slocombe, and S. Murphy. 2011. The "wild" or "feral" distraction: effects of cultural understandings on management controversy over free-ranging horses (*Equus ferus caballus*). *Human Ecology* 39: 613–625.
- Blucher, A., and B. Brown. 2014. Shooting brumbies in Kosciuszko. <http://www.abc.net.au/news/2014-02-27/shooting-brumbies-in-national-parks/5267898>. Accessed on 16 August 2015.
- Bryant, T. 2013. Virtue ethics and animal law. *Between the Species* 16(1): 105–141.

- Burns, G.L., and M. Paterson.** 2014. *Engaging with animals: interpretations of a shared existence*. Sydney, NSW: Sydney University Press: Pp. 276.
- Carruthers, J., L. Robin, J. Hattingh, C. Kull, H. Rangan, and B. van Wilgen.** 2011. A native at home and abroad: the history, politics, ethics and aesthetics of *Acacia*. *Diversity and Distributions* 17(5): 810-821.
- Chew, M.** 2015. Ecologists, environmentalists, experts, and the invasion of the "Second greatest threat". *International Review of Environmental History* 1: 7-40.
- Chew, M., and A. Hamilton.** 2011. The rise and fall of biotic nativeness: a historical perspective. In: *Fifty years of invasion ecology: the legacy of Charles Elton*. (ed. Richardson, D.): Pp. 35-47. Oxford, UK: Wiley-Blackwell.
- Childe, V.G.** 1928. *The most ancient East: the Oriental prelude to European prehistory*. London, UK: Kegan Paul, Trench, Trubner.
- Crosby, A.** 1986. *Ecological imperialism: the biological expansion of Europe, 900-1900*. Cambridge, UK: Cambridge University Press.
- Darwin, C.** 1859. *On the origin of species by means of natural selection*. London, UK: John Murray.
- Darwin, C.** 1872. *On the origin of species by means of natural selection*. London, UK: John Murray.
- Diamond, J.** 2002. Evolution, consequences and future of plant and animal domestication. *Nature* 418: 700-707.
- DotE.** 2015. *Tackling feral cats*. Canberra, ACT: Department of the Environment: Pp. 3.
- East, G.** 1965. *The geography behind history*. New York, NY: W. W. Norton & Company.
- Elton, C.S.** 1958. *The ecology of invasions by animals and plants*. London, UK: Methuen. 196 pp
- Farnham, T.** 2007. *Saving nature's legacy: origins of the idea of biodiversity*. New Haven, CT: Yale University Press 288 pp.
- Gilpin, J.** 1867. On introduced species of Nova Scotia. *Proceedings and Transactions of the the Nova Scotian Institute of Natural Science* 1(2): 60-68.
- Global Crop Diversity Trust.** 2015. Seeds of time. <http://www.seedsofthemovie.com/>. Accessed on 18 August 2015.
- Griffiths, T.** 1996. *Hunters and collectors: the antiquarian imagination in Australia*. Melbourne, Victoria: Cambridge University Press.
- Griffiths, T., and L. Robin (eds).** 1997. *Ecology and empire: environmental history of settler societies*. Edinburgh, UK: Keele University Press.
- Güntürkün, O., M. Stüttgen, and M. Manns.** 2004. Pigeons as a model species for cognitive neuroscience. *e-Neuroforum* 2014: 1-7.
- Gurevitch, J., and D.K. Padilla.** 2004. Are invasive species a major cause of extinctions? *Trends in Ecology and Evolution* 19(9): 470-474.
- Haag-Wackernagel, D., and H. Moch.** 2004. Health hazards posed by feral pigeons. *Journal of Infection* 48: 307-313.
- Haraway, D.** 2015. Anthropocene, Capitalocene, Plantationocene, Chthulucene: making kin. *Environmental Humanities* 6: 159-165.
- Hart, L.** 1995. Dogs as human companions: a review of the relationship. In: *The domestic dog: its evolution, behaviour and interactions with people*. (ed. Serpell, J.): Pp. 161-178: Cambridge University Press.
- Harvey, David** 2011. 'Feral capitalism hits the streets'. <http://davidharvey.org/2011/08/feral-capitalism-hits-the-streets/>
- Head, L., J. Atchison, and A. Gates.** 2012. *Ingrained: a human bio-geography of wheat*. Farnham, UK: Ashgate Publishing Company.
- Hemmer, H.** 1990. *Domestication: The decline of environmental appreciation*. Cambridge, UK: Cambridge University Press.
- Hobbs, R., S. Arico, J. Aronson, J. Baron, P. Bridgewater, V. Cramer, P. Epstein, et al.** 2006. Novel ecosystems: theoretical and management aspects of the new ecological world order. *Global Ecology and Biogeography* 15: 1-7.
- Hobbs, R.** 2009 'Redressing the problem - environmental restoration', Chapter 26 in *Environmental Biology*, Ed. Calver, M., A. Lymbery, J. McComb and M. Bamford, Melbourne, Cambridge University Press, pp. 579-600.
- Human Animal Research Network Editorial Collective (ed.)** 2015. *Animals in the Anthropocene: Critical perspectives on non-animal futures*. Sydney, NSW: Sydney University Press.
- Johnston, J., and F. Probyn-Rapsey (eds).** 2013. *Animal death*. Sydney, NSW: Sydney University Press.
- Kenchington, R.** 1994. Conservation and coastal zone management. In: *Conservation biology in Australia*. eds. Moritz, C. and J. Kikkawa): Pp. 245-250. Chipping Norton, NSW: Surrey Beatty.
- Kohler, Elizabeth,** 2014. *The Sixth Extinction: An Unnatural History*. New York, Henry Holt and Company. 319 pp.
- Larson, B.** 2005. The war of the roses: demilitarizing invasion biology. *Frontiers in Ecology and the Environment* 3(9): 495-500.
- Larson, B.** 2011. *Metaphors for environmental sustainability: redefining our relationship with nature*. New Haven, CT: Yale University Press, 301pp.
- Leatherland, J., and K. Ronald.** 1981. Plasma concentrations of thyroid hormones in a captive and feral polar bear (*Ursus maritimus*). *Comparative Biochemistry and Physiology* 70A: 575-577.
- Long, J.** 1981. *Introduced birds of the world*. Terrey Hills, NSW: Reed.
- Low, T.** 1999. *Feral future: The untold story of Australia's exotic invaders*. Chicago, IL: University of Chicago Press.
- Marris, E.** 2011. *Rambunctious garden: Saving nature in a post-wild world*, New York: Bloomsbury 224pp.
- Marris, E.** 2014. Emma Marris on wolves, new conservation and kids playing in National Parks. *Cool Green Science* (interview with Bob Lalasz) <http://blog.nature.org/science/2014/09/03/emma-marris-wolves-beacon-new-conservation-kids-play-parks/> (accessed 6 September 2016).
- McNaughton, S., R. Ruess, and S. Seagle.** 1988. Large mammals and process dynamics in African ecosystems. *Bioscience* 38(11): 794-800.
- Medina, F., E. Bonnaud, E. Vidal, B. Tershy, E. Zavaleta, J. Donlan, B. Keitt, et al.** 2011. A global review of the impacts of invasive cats on island endangered vertebrates. *Global Change Biology* 17: 3503-3510.

- Olsen, P. 1998. *Australia's pest animals: new solutions to old problems*. Canberra, ACT: Bureau of Rural Sciences.
- PROV. undated. Vermin and Noxious Weeds Destruction Board. <https://researchdata.ands.org.au/vermin-noxious-weeds-destruction-board/492006>. Accessed on 16 August 2015.
- Pyšek, P. 1995. On the terminology used in plant invasion studies. In: *Plant invasions - general aspects and special problems*. eds. Pyšek, P., K. Prach, M. Rejmánek and M. Wade: Pp. 71-81. Amsterdam, Netherlands: SPB Academic Publishing.
- Richardson, D. (ed.) 2011. *Fifty years of invasion biology: the legacy of Charles Elton*. Oxford, UK: Wiley-Blackwell.
- Richardson, D., P. Pyšek, M. Rejmánek, M. Barbour, D. Panetta, and C. West. 2000. Naturalization and invasion of alien plants: concepts and definitions. *Diversity and Distributions* 6: 93-107.
- Robbins, P., and S. Moore. 2013. Ecological anxiety disorder: diagnosing the politics of the Anthropocene. *Cultural Geographies* 20(1): 3-19.
- Robin, L. 2011. The rise of the idea of biodiversity: crises, responses and expertise. *Quaedmi* 76(1): 25-38.
- Robin, L. 2017. Domestication in a post-industrial world. In: *Routledge Companion to the Environmental Sciences*. eds. Heise, U., M. Niemann and J. Christensen): Oxford, Routledge, 480 pp.
- Robin, L., D. Avango, L. Keogh, N. Möllers, B. Scherer, and H. Trischer. 2014. Three galleries of the Anthropocene. *The Anthropocene Review* 1(3): 207-224.
- Robin, L., S. Sörlin, and P. Warde (eds). 2013. *The future of nature: documents of global change* New Haven, CT: Yale University Press 592 pp.
- Rockström, J., W. Steffen, K. Noone, A. Persson, F. Chapin III, E. Lambin, T. Lenton, et al. 2009. A safe operating space for humanity. *Nature* 461: 472-475.
- Rolls, E. 1969. *They all ran wild: the story of pests on the land in Australia*. Sydney, NSW: Angus and Robertson.
- Schnitzler, A., D. Aumaitre, and C. Schnitzler. 2011. From rurality to ferality: a case study from the upper Moselle valley, France. *Revue du Ecologie - la Terre et la Vie* 66(2): 117-133.
- Shelton, J.-A. 2004. Killing animals that don't fit in: moral dimensions of habitat restoration. *Between the Species* 4: 1-19.
- Soulé, M. 1985. What is conservation biology? *Bioscience* 35(11): 727-734.
- Steffen, W. 2013. Commentary on Crutzer and Stoermer. In: *The Future of Nature*. eds. Robin, L., S. Sörlin and P. Warde: Pp. 486-490. New Haven, CT: Yale University Press.
- Steffen, W., W. Broadgate, L. Deutsch, O. Gaffney, and C. Ludwig. 2015. The trajectory of the Anthropocene: the Great acceleration. *The Anthropocene Review* 2(1): 81-98.
- Svihla, A. 1936. The occurrence of albino and spotted rats under feral conditions *The American Naturalist* 70(729): 403-404.
- Theodoropoulos, D.I. 2003. *Invasion Biology: Critique of a Pseudoscience*, Blythe, California: Avvar Books.
- Towns, L., A. Derocher, I. Stirling, N. Lunn, and D. Hedman. 2009. Spatial and temporal patterns of problem polar bears in Churchill, Manitoba. *Polar Biology* 32(10): 1529-1537.
- van Dooren, T. 2011. Invasive species in penguin worlds: an ethical taxonomy of killing for conservation. *Conservation and Society* 9(4): 286-298.
- Wilson, E.O. 1992. *The diversity of life*. Cambridge, MA: Harvard University Press.
- Woods, Rebecca J.H. forthcoming. *The herds shot round the world*. Chapel Hill, NC: University of North Carolina Press. (based on 2011 MIT Thesis of same name)
- Wuerthner, G., E. Crist, and T. Butler. 2014. *Keeping the wild: against the domestication of earth*. Washington, DC: Island Press.
- Zalasiewicz, J., C.N. Waters, Williams, Mark, A.D. Barnosky, A. Cearreta, P. Crutzen, E. Ellis, et al. 2015. When did the Anthropocene begin? A mid-twentieth century boundary level is stratigraphically optimal. *Quaternary International* online 12 January 2015.
- Zeder, M. A. 2015. Core questions in domestication research. *Proceedings of the National Academy of Sciences of the United States of America*, 112(11), 3191-3198. <http://doi.org/10.1073/pnas.1501711112>